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A Preliminary Investigation on the Use of Certain Dried Vegetable Wastes as Poultry Feeds

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A PRELIMINARY INVESTIGATION ON THE USE OF CERTAIN DRIED VEGETABLE WASTES AS POULTRY FEEDS

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Because of wartime shortages of dried skim milk, fish meal, meat scrap, and yellow corn, the poultry feed industry was forced to turn to alfalfa meal as a source of protein, carotene, riboflavin, and the other water soluble vitamin factors. In turn, alfalfa meal supplies became very short. The situation has been critical for some time and more ample supplies of these ingredients are not yet in sight.

Kelley et al (1943) have called attention "to the large quantities of valuable protein, carotene and riboflavin being discarded as vegetable wastes." Their chemical analyses of these wastes showed them to be excellent sources of these factors and in many cases superior to alfalfa meal. As these authors point out, the utilization of vegetable wastes as feed would make possible the efficient use of a by-product now discarded and also supply the feed industry with a sorely needed, high-quality vitamin supplement.

Bird (1944) reported a feeding trial in which dried pea vines were fed and concluded that dried pea vines were a good substitute for alfalfa meal and had the additional advantage of being more palatable.

In October 1943, a preliminary investigation of the use of several dehydrated vegetable wastes in poultry feeds, was undertaken by the Delaware Agricultural Experiment Station, in cooperation with the Bureau of Agricultural and Industrial Chemistry, United States Department of Agriculture.

At the time this work was begun, there had been no research reported in this field. Therefore, this investigation was necessarily of a rather general nature designed largely to discover any existing toxicities of the vegetable wastes and to learn if their vitamin contents were readily utilized by poultry.

PREPARATION OF THE LEAF MEALS

The vegetable leaf meals were prepared from viner and packing house wastes from farms in the vicinity of Philadelphia during the summer and fall of 1943. Fresh pea and lima bean wastes were obtained from the viners at the Seabrook Farms Company, Bridgeton, New Jersey. Carrot tops were obtained during the fall harvest at King Farms Company, and broccoli waste from the packing houses of the King and of the Starkey Farms companies, both at Morrisville, Pennsylvania. Turnips were grown on a small experimental plot on the laboratory grounds and the tops were removed by hand.

Pea vine meal was prepared in an experimental rotary drying unit which proved rather unsatisfactory for the purpose. The other meals were dried in a high-velocity tray drier which proved entirely satisfactory for leaf wastes and allowed the accumulation of considerable data potentially useful for the design of a commercial drier for this type of material.

The pea vine meal was prepared by drying the whole product, subsequently grinding it in a hammer mill and screening on a gyratory screen. The meal used in these feed tests was the fraction passing the 30-mesh screen and was higher in leaf fraction than the discarded portion. It was inferior to the other leaf meals used in this series largely because of overheating during drying. Better quality pea vine meals can certainly be prepared.

The lima bean meal was prepared by drying the leafy fraction from the viner, screening off dirt on a 60-mesh screen, and then grinding to approximately 20 mesh.

Broccoli, turnip, and carrot leaf meals were prepared by drying in the tray drier until the leaf blades were brittle and the stems were still damp and limp. Immediate rotation in a trommel screening device with stones gave a good separation of leaf from stem material and the separated leaf portion was then ground to 20-mesh size.

The various leaf meals were barreled and kept in cold storage until ready for use in the feeding tests.

CHEMICAL ANLYSIS OF WASTES

The anaylsis of the five leaf meals and of the alfalfa leaf meal used for comparison are shown in Table 1.

After mixing, the various mashes were stored during use in the poultry house under the usual winter conditions. Table 2 gives the analysis of the mashes, with figures for the vitamin content both at the beginning and the end of storage.

In Figures 1 through 4, the riboflavin and carotene content of the pure vegetable wastes and the mixed mashes are presented in graphic form to show their relative potency. Their loss in carotene and riboflavin during storage has been indicated not as a definite index of probable losses, but merely to show the levels of riboflavin and carotene existing at the end of the feeding trial as a matter of interest.

Table 1 Composition of Leaf Meals

Leaf Meal	Per cent Moisture	Per cent Protein	Per cent Crude Fiber	Carotene, I. U./lb.*		Riboflavin, Micrograms/lb.	
				At Start	At Completion	At Start	At Completion
Alfalfa	7.9	20.2	24.8	47,700	39,300	6,220	4,540
Pea Vine	6.5	17.2	16.5	23,400	20,400	6,995	6,950
Lima Bean Vine	3.2	11.9	5.8	130,000	113,500	3,995	3,995
Turnip	9.6	26.2	7.6	298,000	296,000	9,080	7,630
Broccoli	6.9	32.4	7.1	373,000	336,000	12,720	10,615
Carrot	8.9	14.0	8.9	86,500	68,000	3,995	3,583

*I. U. —International Units per pound.

Table 2. Composition of Mixed Mashes

Mash	Per cent Moisture	Per cent Protein	Per cent Crude Fiber	Carotene, I. U./lb.*		Riboflavin, Micrograms/lb.	
				At Start	At Completion	At Start	At Completion
Alfalfa	10.2	20.8	6.5	4,500	3,320	1,410	1,271
Pea Vine	10.5	20.0	5.0	2,200	2,200	1,568	1,500
Lima Bean Vine	10.1	19.8	4.4	9,000	8,200	1,290	932
Turnip	10.2	20.4	4.5	21,000	16,200	1,558	1,543
Broccoli	10.3	21.6	4.3	26,400	23,600	1,976	1,908
Carrot	10.4	19.4	5.2	5,900	6,200	1,430	1,410
Negative Control	10.0	20.2	3.8	0	0	1,290	932

*I. U. —International Units per pound.

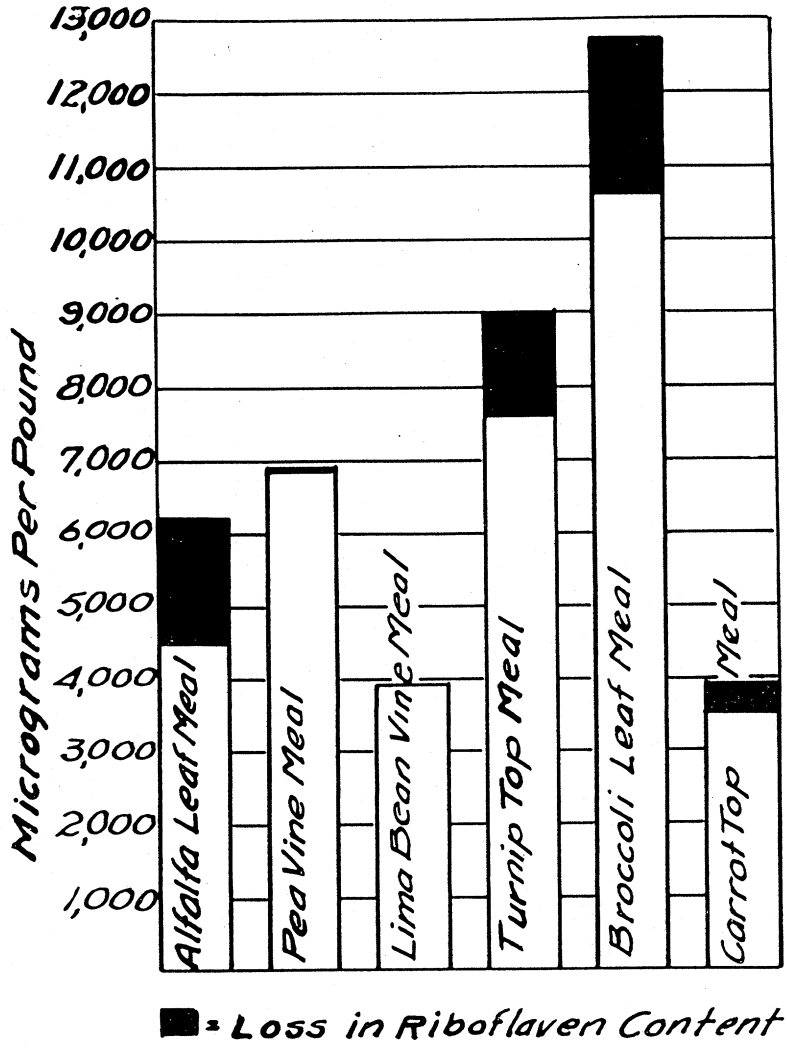

Figure 1. Riboflavin Content of the Leaf Meals and Their Loss in Potency During Three Months' Storage.

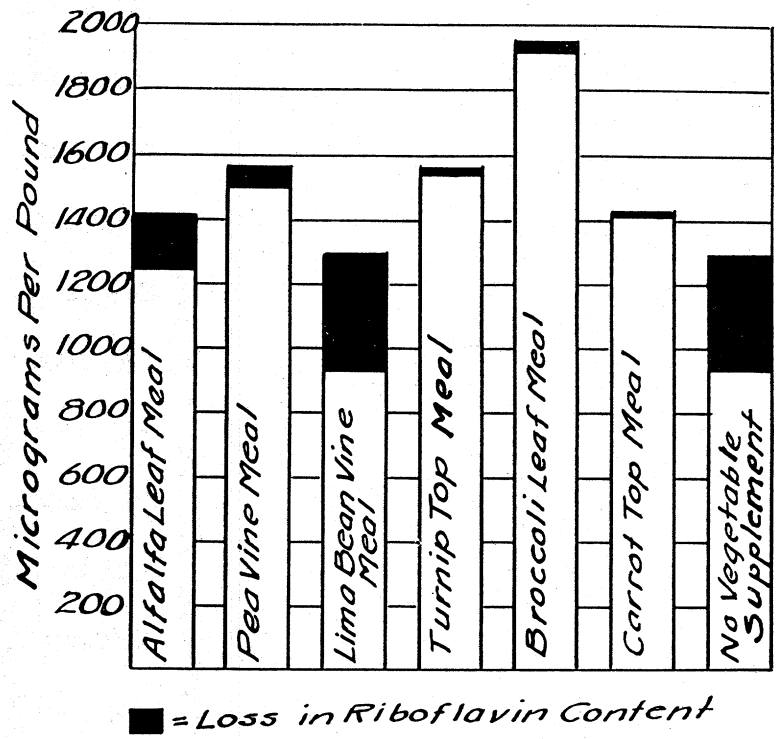

Figure 2. Riboflavin Content of the Mixed Mashes and Their Loss in Potency During Three Months' Storage.

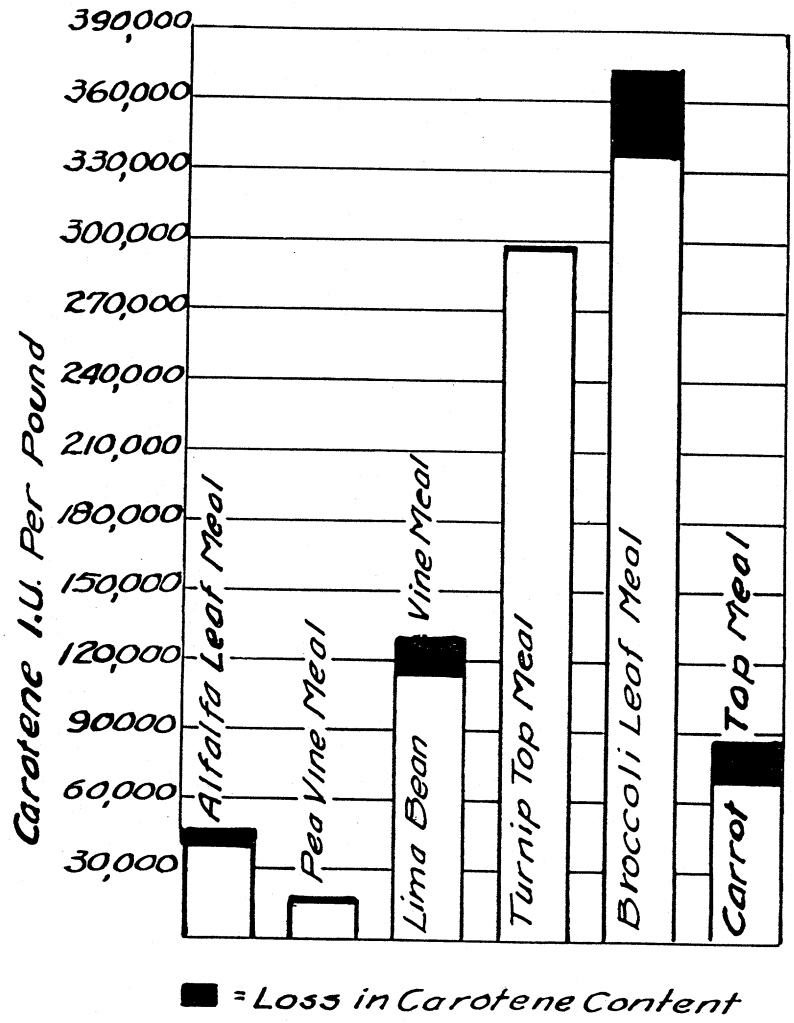

Figure 3. Carotene Content of the Leaf Meals and Their Loss in Potency During Three Months' Storage.

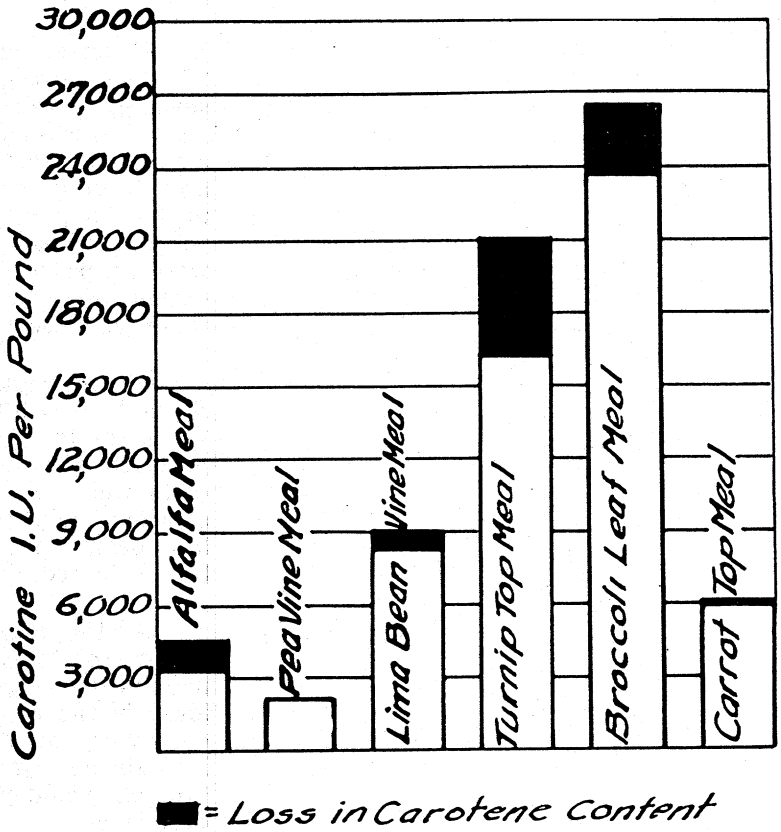

Figure 4. Carotene Content of the Mixed Mashes and their Loss in Potency During Three Months' Storage.

EXPERIMENTAL PROCEDURE

It was decided to study the utilization of these wastes by substituting them for alfalfa leaf meal in a broiler mash. A formula containing a rather high level of alfalfa leaf meal that had given good results in previous feeding trials at the Delaware Station, was used because it was desired to show the effects of these wastes at the highest practicable level used for alfalfa leaf meal.

Fourteen hundred New Hampshire chicks hatched on October 26, 1943, were used in this experiment. They were divided into seven groups of 200 chicks and housed in 12′ x 12′ colony houses. Each house was provided with a 6′ x 12′ sunporch to which the chicks had access at all times. Coal stoves were used for heat and the equipment and management of each colony house was as nearly identical as possible. The experimental diet and water was offered to the chicks **ad libitum** and feed consumption records were recorded weekly. The broilers were group-weighed weekly except at 8 and 14 weeks of age, when individual weights were taken and the broilers scored for feathering and pigmentation.

The formulae of the experimental diets are presented in Table 3. It will be noted that the vegetable wastes were substituted for the 8 per cent alfalfa leaf meal, pound for pound, regardless of their protein and vitamin content. Although some diets were far in excess of maximum requirement for certain nutrients none were below minimum requirements except the lima bean, carrot top, and negative control rations which might be considered marginal in riboflavin.

All the diets, and especially those with broccoli, turnip tops, and carrot tops, retained the distinctive odor of the vegetable indefinitely. Even after 6 weeks' storage, it was possible to identify the ration being fed upon entering the pen. However, only the odor of the broccoli diet was pungent enough so that it might be objectionable but because of its high-vitamin potency, broccoli would probably never be used in practice at the 8 per cent level.

If dried vegetable wastes are to be substituted for alfalfa leaf meal in poultry feeds, the following considerations are of importance: growth-promoting value, yellow pigment-producing value, efficiency of feed utilization, effect on rate of feathering, mortality, pasting up of chicks, and the palatability of the wastes.

Table 3. Formulae of Rations Used and Their Caluculated Analysis

	Alfalfa	Pea Vines	Lima Bean Vines	Turnip Tops	Broccoli	Carrot Tops	Negative Control
Ingredients							
Ground yellow corn	30	30	30	30	30	30	35
Ground oats	15	15	15	15	15	15	15
Wheat bran	10	10	10	10	10	10	10
Cracked wheat	10	10	10	10	10	10	10
Soybean oil meal	20	20	20	20	20	20	22
Meat scrap (50%)	5	5	5	5	5	5	5
Steamed bone meal	1	1	1	1	1	1	1
Oyster shell flour	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Salt mix #	.5	.5	.5	.5	.5	.5	.5
D. activated animal sterol (2000D)	.05	.05	.05	.05	.05	.05	.05
Alfalfa leaf meal	8						
Pea vine meal		8					
Lima bean vine meal			8				
Turnip top meal				8			
Broccoli leaf meal					8		
Carrot top meal						8	
Totals Lbs.	101.05	101.05	101.05	101.05	101.05	101.05	100.05
Calculated Protein, Per cent	20.12	19.84	19.35	20.69	21.15	19.60	19.69
Carotene, Micrograms Per lb.	2866	1697	6840	14935	18549	4722	666
Vitamin A Equivalent, I. U. Per lb.	4786	2833	11426	24941	30976	7885	1112
Riboflavin, Micrograms Per lb.	1173	1231	922	1397	1687	992	723

Contains 2 lbs. of anhydrous manganous sulfate to 100# of salt.

RESULTS AND DISCUSSION

Growth

The average weekly weights of the broilers are reported in Table 4. The birds fed diets containing vegetable wastes grew as well or better than the group fed alfalfa, except for those fed pea vines.

As has been suggested, the sample of dried pea vines available for this experiment was not dried properly and was rather low grade in terms of the possibilities in drying pea vines. By the ninth week it became evident that broilers fed the pea vine diet were not able to maintain as rapid growth as those fed the alfalfa control and the other vegetable waste diets. It was also observed that the group fed pea vines did not recover as rapidly as the other groups after an attack of cecal coccidiosis at about 11 weeks of age. This slow convalescence has been recognized as characteristic of broilers fed marginally deficient diets.

Although the group fed turnip tops started a little more slowly than the others, their rapid growth during the last part of the feeding period enabled them to finish on a par with the alfalfa group. For some reason chicks started on this diet consumed much less feed per bird during the first few weeks than chicks started on the other diets. Palatability tests made with broilers 9 weeks of age show the turnip top diet to be as palatable as the others so it is concluded that discrimination against this diet by the chicks was not the limiting factor involved.

The groups fed carrots and broccoli were slightly heavier than the others at 14 weeks of age, but this advantage appeared only after the 12th week. Before that there was little difference between any of the pens except for the slower growing pea vine and the negative control groups.

Broccoli fed at the 8 per cent level caused the droppings to be slightly sticky. This condition did not seem to affect the health of the birds in any way, but it was difficult to maintain satisfactory litter conditions. Because of broccoli's high protein, carotene, and riboflavin content it would seem unnecessary to use this product at such a high level so that its effect on the consistency of the droppings should not be a serious disadvantage.

It is recognized that the growth obtained in this experiment was only about 80 per cent of what is considered normal. This retarded growth may have been due to the use of poor quality soybean oil meal in mixing the diets. When the experimental diets were mixed, soybean oil meal was in extremely short supply, and a hydraulic meal that was definitely beany in taste was the only soybean oil meal available.

In order to check on this poor soybean oil meal(sample No. 1) as a possible cause of the slow growth a sample of properly prepared soybean oil meal (sample No. 2) was secured and a feeding trial set up in the battery using the alfalfa diet with

both samples of soybean oil meal. Fifty cross bred chicks were fed each mash and a third group was fed a nationally known broiler mash as a further check.

The results of this test are given in Table 5 and they tend to confirm the idea that the slow growth secured in the vegetable waste feeding trial was due in the main to the use of inferior soybean oil meal.

Table 5. Effect of Soybean Oil Meal Used in Ration on Growth of Chicks

Feed	Average weight of chicks at 4 weeks of age	Average weight expressed as an index number
	Grams	
Alfalfa Ration with Soybean Oil Meal Sample No. 1	170	75
Alfalfa Ration with Soybean Oil Meal Sample No. 2	226	99
A First Quality Commercial Broiler Mash	227	100

In Figure 5 the weekly growth of each group fed the various waste is plotted against the alfalfa meal control.

Table 4. Average Weekly Body Weight per Bird

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Bean Vines	Turnip Tops	Broccoli	Carrot Tops	None
Weeks	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1	.15	.13	.13	.13	.13	.13	.12
2	.20	.19	.19	.18	.19	.18	.17
3	.29	.28	.28	.25	.28	.25	.23
4	.40	.38	.39	.36	.45	.38	.34
5	.53	.50	.48	.48	.55	.49	.44
6	.69	.66	.70	.62	.72	.64	.53
7	.91	.80	.90	.81	.90	.84	.71
8	1.04	.94	1.05	1.05	1.09	1.05	.83
9	1.32	1.13	1.27	1.28	1.30	1.24	.96
11	1.77	1.43	1.64	1.73	1.83	1.74	1.22
12	2.06	1.61	1.94	2.02	2.03	2.08	1.53
13	2.36	1.95	2.24	2.34	2.44	2.20	1.72
14	2.55	2.10	2.51	2.59	2.74	2.66	1.94

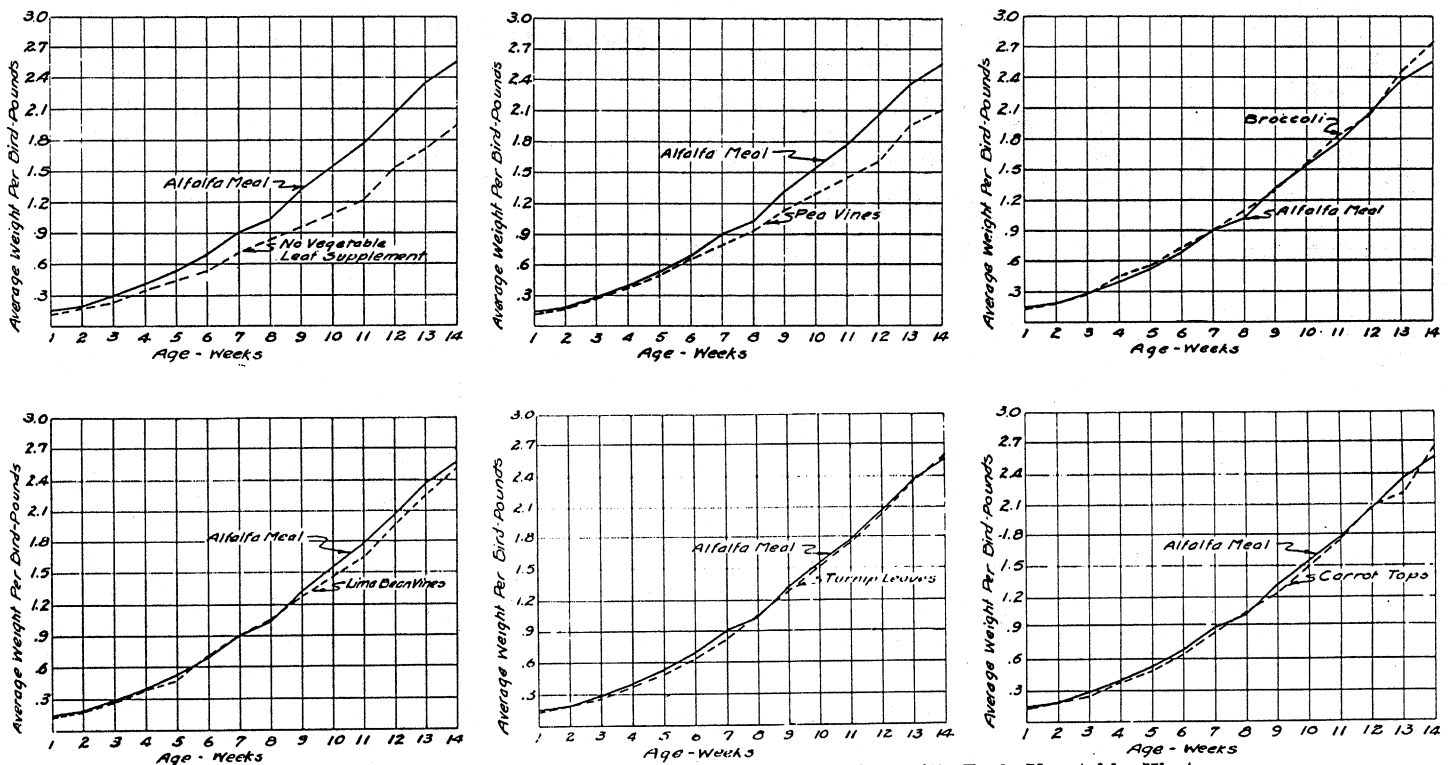

Figure 5. Growth of Broilers over the 14-Week Period with Each Vegetable Waste Compared to Alfalfa Leaf Meal.

Figure 6 shows the percentage of males in each group over 3 pounds in weight at 14 weeks of age and Figure 7 the percentage of females over 2.5 pounds. It seems reasonable to conclude from these data that the broccoli and carrot groups were definitely superior to the alfalfa control at 14 weeks of age.

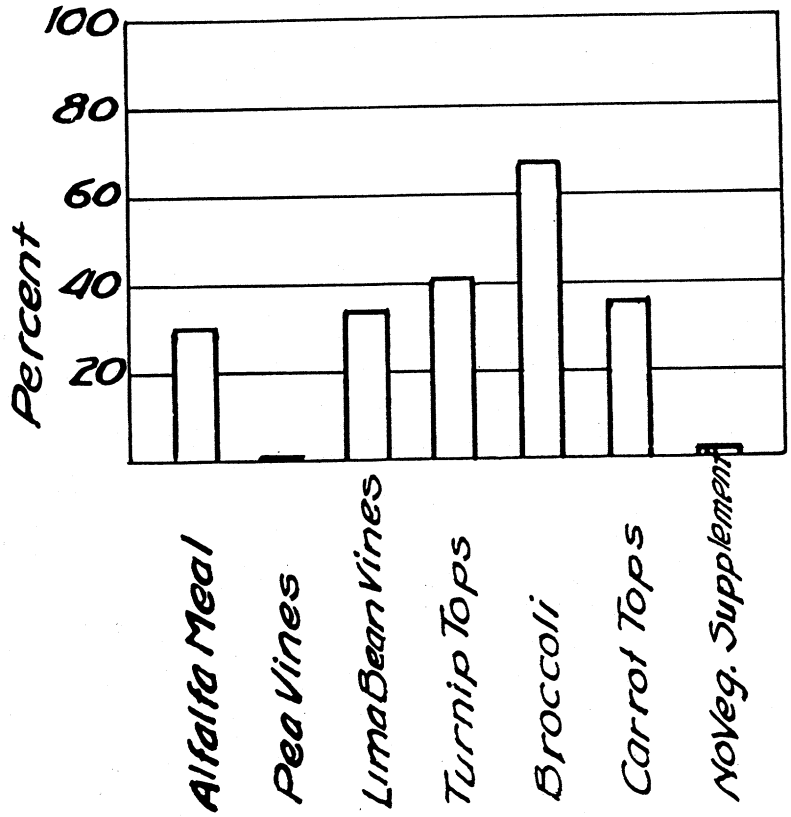

Figure 6. Percentage of Males over 3 Pounds in weight for Each Group at 14 Weeks of Age.

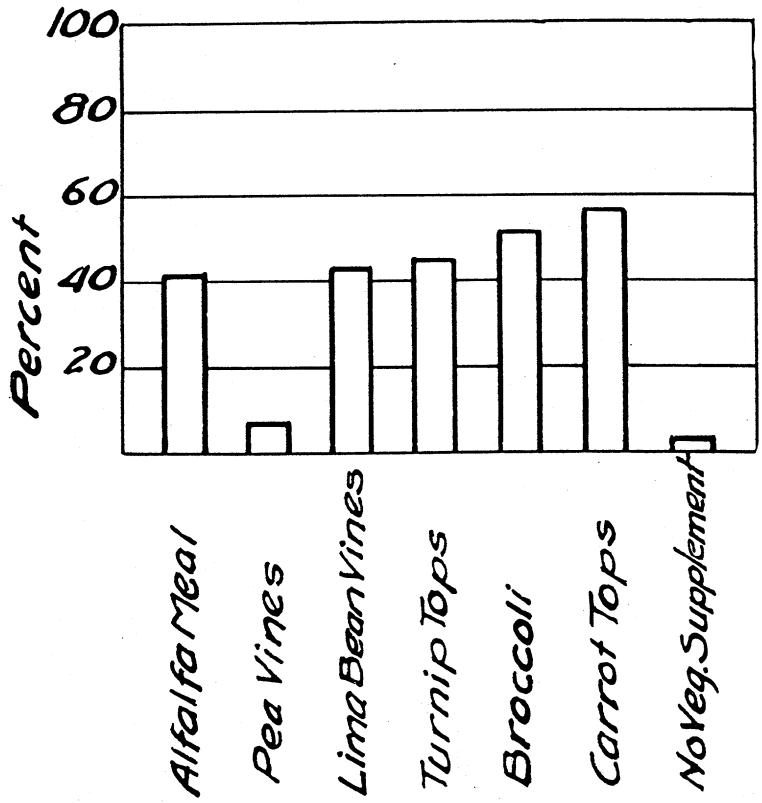

Figure 7. Percentage of Females over 2.5 Pounds in Weight for Each Group at 14 Weeks of Age.

Feed Consumption and Efficiency

Weekly feed consumption per bird, given in Table 6, shows a remarkably similar feed consumption for all groups for the 14-week period except for the negative control lot. As has been noted in the discussion on rate of growth, the group on the turnip top diet had a considerably lower feed consumption during the first four weeks.

Table 6. Weekly Feed Consumption per Bird

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Beans Vines	Turnip Tops	Broccoli	Carrot Tops	None
Weeks	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
1	.13	.13	.14	.11	.13	.12	.14
2	.19	.19	.17	.16	.17	.17	.16
3	.32	.36	.32	.28	.30	.28	.27
4	.39	.39	.39	.34	.37	.38	.32
5	.47	.47	.48	.50	.49	.47	.41
6	.63	.64	.66	.57	.66	.63	.44
7	.78	.70	.76	.71	.72	.73	.56
8	.85	.74	.86	.86	.94	.93	.68
9	.99	.93	1.03	1.00	.96	1.05	.73
10	1.14	1.04	1.10	1.15	1.13	1.12	.70
11	1.40	1.41	1.41	1.30	1.40	1.47	1.03
12	1.44	1.03	1.30	1.47	1.40	1.42	1.08
13	1.53	1.32	1.55	1.46	1.53	1.43	1.40
14	1.50	1.37	1.61	1.58	1.62	1.60	1.20
Total	11.76	10.72	11.78	11.49	11.82	11.89	9.12

Gross feed efficiency, which was calculated by dividing the average gain in weight per bird into the average feed consumption per bird for the period, is presented in Table 7. Although feed consumption was rather uniform, the gain from week to week varied considerably between groups and also from one week to the next for the same group. Bi-weekly, rather than weekly data are given in this table to smooth out the irregularities and to make it easier to see the trend toward lower efficiency of feed utilization on the part of the pea vine diet. Presumably the

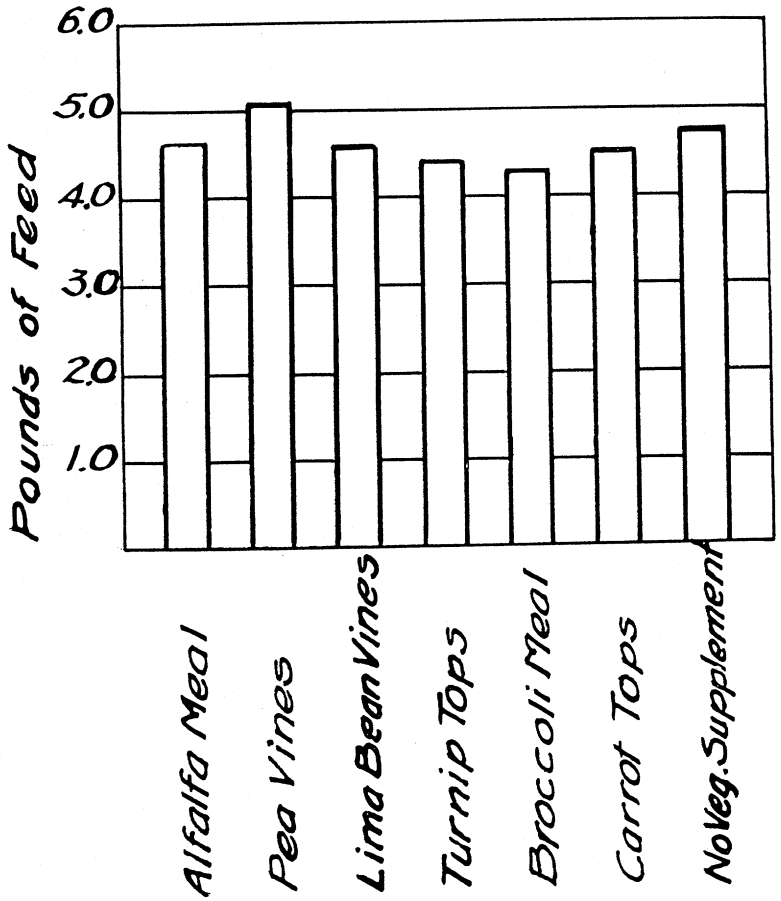

Figure 8. Pounds of Feed per Pound of Grain for Each Group over the 14-Week Feeding Period.

Table 7. Pounds of Feed Required per Pound of Gain

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Bean Vines	Turnip Tops	Broccoli	Carrot Tops	None
Weeks	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
0-2	2.74	2.88	2.79	2.71	2.65	2.95	3.34
2-4	3.59	4.00	3.55	3.40	2.77	3.52	3.55
4-6	3.73	3.88	4.18	4.14	4.52	4.19	4.59
6-8	5.02	5.22	4.78	3.66	4.43	3.97	4.38
8-10	4.59	6.53	5.77	4.89	4.67	5.48	4.54
10-12	5.38	6.93	5.52	5.22	5.93	4.67	5.05
12-14	6.38	7.79	5.01	5.36	4.41	7.71	6.57
Entire Period	4.61	5.11	4.57	4.41	4.29	4.49	4.73

negative control which contained no vegetable supplement should be less efficient too, but the excessive mortality in this group tends to obscure the manifestation of other variables. The feed efficiency of the several diets over the entire 14-week period is shown graphically in Figure 8. Although no significant differences were found, the trend seemed to be toward increased efficiency for broccoli and, to a lesser degree, the other wastes as compared to alfalfa. Pea vines, however, showed a sharp decrease in efficiency as compared to alfalfa which again was probably influenced by the poor quality of the pea vine sample used.

Mortality

Table 8 showing the number of birds that died each week and the percentage of mortality for the 14-week feeding period requires little comment. Differences in mortality between the groups fed the vegetable products are not significant and slightly lower than might be expected, while the difference between them and the group that was fed no vegetable product is highly significant.

Observations were made to determine the amount of "pasting up" resulting from various diets and any possible correlation that might exist between "pasting up" and mortality. These data are presented in Table 9.

At first glance it would appear that the alfalfa control did not cause as much pasting up as the other diets which in turn made for better livability, but the chicks on the negative control pasted up as badly as any and there is no reason to suppose that this diet should cause any digestive disturbance. Moreover, the broccoli diet, which had the most laxative effect of any of the diets, produced the smallest amount of pasting up and fairly low mortality. Because the causes of pasting up are not well understood and a wide variety of causes have been suggested, it does not seem reasonable to conclude from these data that the vegetable wastes included in the diets caused a higher incidence of this condition.

Pigmentation

The degree of pigmentation induced by a diet is important because poultrymen and poultry buyers alike use it as an index of a bird's health and finish. In order to evaluate the degree of pigmentation of the broilers on the various diets, the shank color of each bird was scored at 8 weeks of age. Possible scores ran from 1, a deep orange-yellow, down to 4 which was definitely whitish. After the scores were averaged they were changed to index numbers to throw the differences into sharper contrast. These data are presented in Table 10.

The broccoli fed birds had almost perfect pigmentation, only a few individuals scoring as low as 2. The turnip top group was almost as good even though the recorded data place them about

Table 8. Mortality of The Various Groups by Weeks

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Beans	Turnip Tops	Broccoli	Carrot Tops	None
Weeks	No. Died	No. Died	No. Died	No. Died	No. Died	No. Died	No. Died
1	1	9	2	8	5	5	5
2	0	2	2	2	2	1	9
3	0	0	1	1	1	0	3
4	0	0	0	0	0	0	5
5	1	0	0	1	0	0	7
6	0	0	0	0	0	0	10
7	1	0	0	1	0	0	7
8	0	1	0	1	0	2	7
9	0	2	2	1	0	1	1
10	2	2	1	0	3	1	12
11	5	3	3	3	1	1	21
12	3	6	1	4	2	0	32
13	2	4	3	0	2	0	0
14	7	1	0	1	3	1	1
Total	22	30	15	23	19	12	120
Per cent mortality to 14 weeks	11	15	7.5	11.5	9.5	6	60

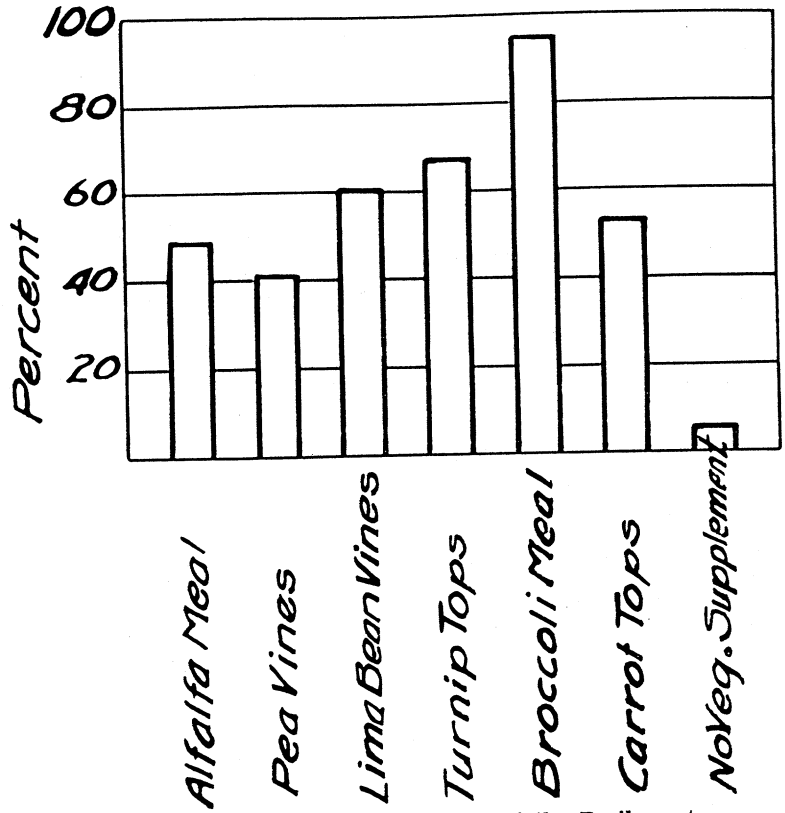

Figure 9. Average Pigmentation Score of the Broilers at 14 Weeks of Age.

30 per cent behind the broccoli. Unfortunately, a large number of birds in this group had a degree of pigmentation between 1 and 2 and were put in the 2 group because it did not seem advisable to introduce a new value in the scoring system used. A careful observation of the birds in their pens suggested that a score midway between the broccoli and the lima bean fed group, which was third, best, would be a more accurate evaluation of the shank color of the group on the turnip top diet. The average pigmentation score of the broilers fed the various diets is shown graphically in Figure 9.

Feathering

There were no differences in degree of feathering observed at 8 weeks of age between the various diets. All the chicks possessed the sex-linked recessive gene for rapid feathering and they were brooded during a cool part of the year which would tend to cover up any slight superiority on the part of one diet to produce more rapid feathering than another.

Table 9. Amount of Pasting up and Early Mortality on The Various Diets

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Beans	Turnip Tops	Broccoli	Carrot Tops	Negative
No. pasted at 1 week of age	14	46	48	42	36	58	56
Mortality 1st wk. Mortality 2nd wk.	1 0	9 2	2 2	8 2	5 2	5 1	5 9
Total mortality for 2 weeks	1	11	4	10	7	6	14

Table 10. Shank Color Index* of Broilers at 8 Weeks of Age

	Vegetable Product Fed						
Sex	Alfalfa	Pea Vines	Lima Beans	Turnip Tops	Broccoli	Carrot Tops	None
Males Females	56 40	46 36	59 60	67 66	96 95	59 47	8 5
Combined Sexes	48	41	59.5	66.5	95.5	53	6.5

*A score of 100 would mean that every bird in the pen scored 1 in pigmentation where 1 is deepest orange

Table 11. Palatability of The Various Vegetable Wastes in Comparison with That of Alfalfa Leaf Meal

	Pounds of Vegetable Product Consumed					
	Alfalfa	Pea Vines	Lima Bean Vines	Turnip Tops	Broccoli	Carrot Tops
1st trial	2.6	2.6				
2nd trial	.20	1.9				
Total	2.80	4.5				
1st trial	2.7		6.0			
2nd trial	.50		5.4			
Total	3.20		11.4			
1st trial	.80			5.7		
2nd trial	.85			5.55		
Total	1.65			11.25		
1st trial	.20				5.20	
2nd trial	.20				4.90	
Total	.40				10.10	
1st trial	.50					4.6
2nd trial	.20					5.3
Total	.70					9.9
Per cent vegetable wastes of total feed consumed						
1st trial		50	69	88	96	90
2nd trial		90	92	87	96	96
Average per cent vegetable waste consumed based on total consumption for both trials.		62	78	87	96	93

Palatability

A flock of 375 Barred Rock-New Hampshire cross broilers was used to study the palatability of the vegetable wastes. The regular growing mash was removed from the pen and two hoppers of alfalfa leaf meal and two hoppers of one of the vegetable wastes were offered to the birds at 10:00 A. M. and were removed the same time on the following day. After 24 hours on the regular growing mash, this process was repeated using a different waste until all five had been tried. Two trials were made, one when the broilers were 6 weeks of age, and another when they were 9 weeks old. Although growth was depressed slightly, there was no excessive mortality and the birds came through this severe treatment in good condition.

The consumption of the vegetable wastes and alfalfa meal is given in Table 11. It is readily evident that all the wastes studied are more palatable than alfalfa leaf meal. Although the position of the hoppers was changed between tests the broilers evidently learned rather quickly that there was something available more desirable than alfalfa meal because they refused to consume an appreciable amount of alfalfa after the first trial on pea and lima bean vines.

Unfortunately the mechanical condition of the alfalfa differed from the vegetable wastes in that it was much more finely ground. The preference of poultry for coarsely ground feedstuffs is generally accepted, but it does not seem reasonable to expect that mechanical condition alone could cause such a wide difference in consumption especially since alfalfa meal is notorious for its unpalatability. The common opinion that alfalfa leaf meal may be discriminated against by chickens because of its bitter taste is confirmed by these tests because the pea vine meal was definitely the most bitter of all the vegetable wastes. This was due to the higher stem content of the pea vine meal. Birds fed this meal ate less than half of what they consumed when offered the other wastes for the same period of time.

In another palatability test, 350 Barred Rock-New Hampshire cross broilers 9 weeks of age were given 7 hoppers of feed, each one containing one of the mashes used in this study. Hence mashes containing 8 per cent of the following vegetable products were used: alfalfa leaf meal, pea vines, lima bean vines, turnip tops, broccoli, and carrot tops. One mash used contained no vegetable product. The location of the hoppers was changed daily and at the end of one week's time no difference in consumption between mashes were observed except that the broilers seemed to prefer the negative control mash containing no vegetable product for the first four days. From the fifth day on they consumed no more of this mash than the others so that at the end of the week consumption was 40 pounds for each of the mashes containing a vegetable product and 45 pounds for that mash containing none. It is apparent that even when used at such a high level as 8 per cent of the diet, alfalfa leaf meal and the vegetable wastes did not impair the palatability of the mashes.

SUMMARY

A preliminary investigation on the use of dried vegetable wastes as poultry feed was made using dried pea vines, lima bean vines, turnip tops, broccoli, and carrot tops for 8 per cent alfalfa leaf meal in a practical all mash broiler ration. The observations made are summarized in Table 12 and in the following statements:

1. All of the wastes used may be fed to broilers or other growing birds at as high a level as 8 per cent of the total feed intake with no harmful effect on the birds.

2. Broilers fed the broccoli, and those fed the turnip top diet used their feed more efficiently than those fed alfalfa leaf meal while those fed lima bean vines and carrot tops required approximately the same amount of feed per pound of gain as those on alfalfa. The pea vine diet was definitely less efficient than any of the others, but this may have been due to the admittedly poor sample of dried pea vines used.

3. Although most of the advantage appeared after the broilers were 12 weeks of age, the broccoli and carrot diets produced heavier birds, while the lima bean and turnip top diets produced birds as heavy as the alfalfa leaf meal control at 14 weeks of age. Broilers fed pea vines lagged approximately one-half pound per bird behind the alfalfa group at 14 weeks.

4. There were no significant differences in mortality between the various groups fed alfalfa or vegetable wastes. The negative control, containing no vegetable supplement, had about six times the mortality of the other groups.

5. Average feed consumption per bird was remarkably uniform indicating that all the diets were palatable to the broilers.

6. The broccoli and turnip top diets produced a significantly greater degree of pigmentation than the alfalfa leaf meal. Birds fed lima bean vines and carrot tops were slightly superior, but those on pea vines were definitely inferior in pigmentation to birds fed the alfalfa leaf meal diet.

7. All the vegetable wastes were more palatable than alfalfa leaf meal as determined by giving broilers their choice of one of the wastes or alfalfa leaf meal in separate hoppers. There was little difference between broccoli, carrot tops, turnip tops, and lima bean vines, but the pea vines were definitely less palatable.

8. When broilers were given their choice of the seven mixed rations, no differences in palatability were observed.

Table 12. Summary of Results at End of The 14 Week Period

	Vegetable Product Fed						
	Alfalfa	Pea Vines	Lima Bean Vines	Turnip Tops	Broccoli	Carrot Tops	None
Per cent mortality	11	15	7.5	11.5	9.5	6.0	60
Average weight per bird, lbs.	2.55	2.10	2.51	2.59	2.73	2.65	1.91
Average feed consumption per bird, lbs.	11.78	10.71	11.76	11.46	11.81	11.87	9.11
Pounds of feed per lb. of gain, lbs.	4.6	5.1	4.6	4.4	4.3	4.5	4.7
Pigmentation index*	48	41	59.5	63.5	95.5	53	6.5
Palatability Index**	—	62	78	87	96	93	—

* An index of 100 would mean that every bird in the group had scored perfect in pigmentation.

**An index of 100 would mean that broilers given their choice would eat that feedstuff to the complete exclusion of alfalfa leaf meal.

CONCLUSIONS

Dried vegetable wastes make excellent poultry feed and, where quality control of the dried product has been maintained, are equal to or superior to alfalfa leaf meal. From their chemical analysis and their performance in this experiment, it is concluded that they are excellent sources of carotene, riboflavin, and other water-soluble vitamins. Considering their higher vitamin concentration, a relatively lower level would be required. Therefore, it is evident that a higher price could be paid for a meal of high-vitamin content such as broccoli than for alfalfa leaf meal. It would seem that the large amounts of vegetable wastes now discarded ought to be exploited and their nutrients utilized. The conclusion seems justified on the basis of this experiment that these products are of value to the poultry-feed industry if available at a competitive price level.

Literature Cited

Kelley, Edward G., Wall, Monroe E., Willaman, J. J. 1943. Vegetable Wastes as Animal Feedstuffs. Feedstuffs 15, June 26, p. 18.

Bird, H. R., 1944. Dehydrated Pea Vines and Starfish Meal in Poultry Feeds. Poultry Sci. 23, No. 1, p. 76.